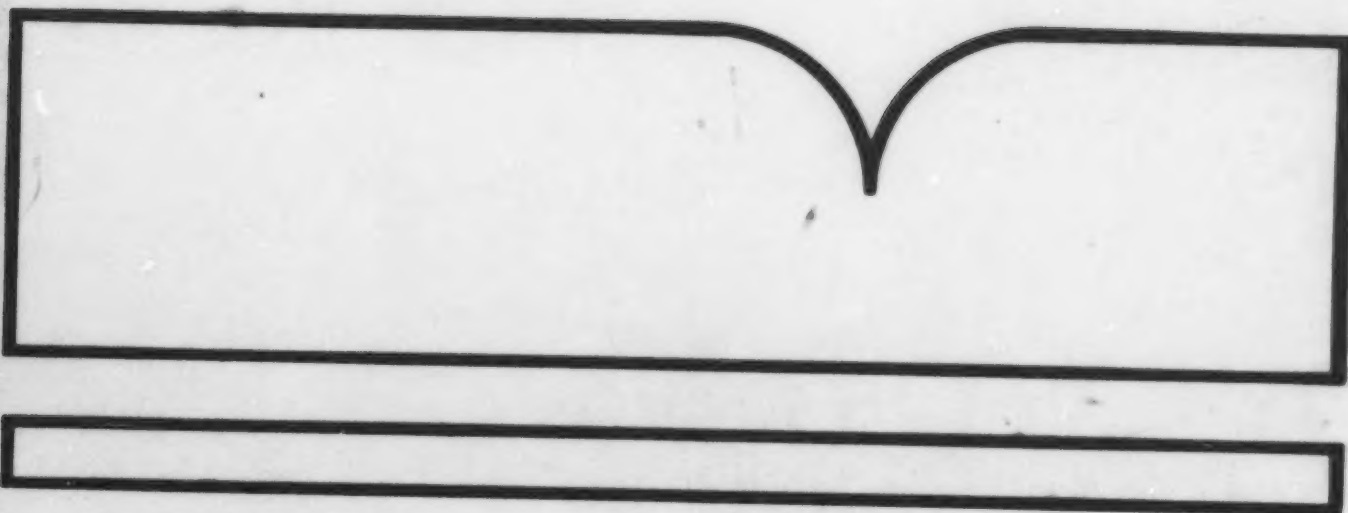


Chesapeake Bay

(U.S.) Environmental Protection Agency
Washington, DC

May 80



U.S. Department of Commerce
National Technical Information Service

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Office of Research and Development



EPA Research Summary

Chesapeake Bay



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What is the environmental future of Chesapeake Bay? EPA's Office of Research and Development, in conjunction with the Agency's Regional Office in Philadelphia, is sponsoring a cooperative effort among the concerned public, private institutions, and state and federal agencies to document both the Bay's environmental quality and the management of its resources. We are hopeful that this cooperative approach will ultimately lead to consensus as to how this valuable estuary can best be protected. This summary of our Chesapeake Bay Program activities is the first of several documents the Office of Research and Development will publish commemorating 1990 as the Year of the Coast. With your help the abundant coastal resources we enjoy today will be preserved for the benefit of others in the future.

Stephen J. Gage



Assistant Administrator
for Research and Development

This brochure is one of a series providing a brief description of major areas of the Environmental Protection Agency's research and development program. Additional copies may be obtained by writing to:

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Cover photo by Una Flynn

*This report
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resources and
management of
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BIBLIOGRAPHIC INFORMATION

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KEYWORDS: *Water pollution, *Chesapeake Bay.

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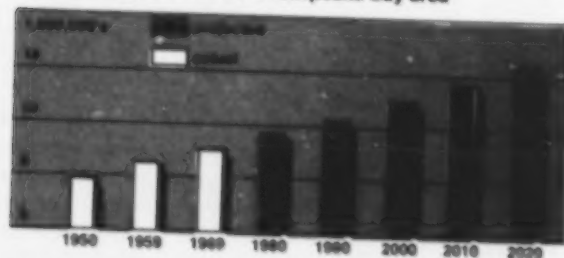
bay environment

The largest estuary in North America, a primary source of crabs for human consumption, a major cargo route for East Coast maritime commerce, and an irreplaceable recreational resource — the Chesapeake Bay's waters touch the lives of people far beyond its thousands of miles of tidal shoreline. As man's activities encroach on the natural ecology of the Bay, its delicate equilibrium is changing. We can have a positive influence on these changes through a greater understanding of the dynamics of the Bay's ecosystem. Scientists in federal, state and local government and in private institutions are cooperating in a diverse research program to develop the knowledge necessary to preserve and enhance this priceless national resource.

resources

Of the more than 800 estuaries and bays in the United States, the Chesapeake Bay is the largest: 190 miles long with about 8,000 miles of shoreline and 4,300 square miles of water surface. It has a drainage basin of about 64,000 square miles and is fed by over 150 rivers and tributaries. About 90 percent of the fresh water entering the Bay system comes from five major rivers: The Susquehanna, Potomac, Rappahannock, York, and the James. The

population growth in the Chesapeake Bay area



Susquehanna provides 50 percent of the freshwater entering the bay.

From Colonial times on, the Bay area has provided the natural resources for thriving commercial, agricultural, and recreational pursuits. Over the years, rising demand for these resources, increasingly sophisticated technology used to exploit them, and areawide population growth have combined to put increasing pressure on the Bay's capability to sustain its natural resources. This pressure will accelerate in the future as the Bay area population is expected to increase by more than 75% over the next 40 years.

The Chesapeake Bay has always been an important economic resource. Its waters provide access to Baltimore Harbor, Maryland, and Hampton Roads, Virginia, two major East Coast ports, as well as to numerous smaller ports throughout the Bay area. The amount of cargo moving into and out of Chesapeake Bay ports has risen in recent years and is expected to increase significantly in the future. Maritime commerce projections estimate that the volume of cargo handled in Baltimore Harbor and Hampton Roads will double in the next 40 years. This means more and larger vessels will be plying the waters of the Chesapeake in the future.

Recreational activities on the Bay, such as boating, sport fishing, shellfishing, hunting, and camping, are also expected to increase significantly in the future. For example, the US Army Corps of Engineers in their Future Conditions Report on the Chesapeake Bay has estimated that for boating activities alone, demand will rise from about 11 million activity days in 1980 to more than 36 million days in 2020.

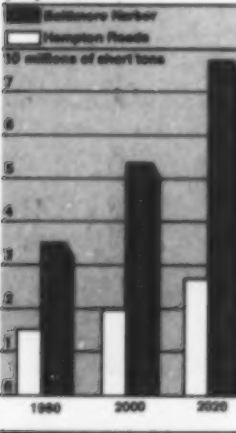
The productive waters of the Bay support thriving commercial fin-fishing, shellfishing and seafood processing industries, whose revenues amount to many millions of dollars per year. The staple crops of these industries are the Chesapeake Bay blue crab, oyster, and soft-shelled clam. More oysters are caught in the Bay than anywhere else in the nation, totaling more than one fourth of the annual national catch. The blue crab is fished all along the east coast and in the Gulf of Mexico, yet the Bay produces more blue crabs in a year than all other areas combined. The Bay soft-shelled clam fishery accounts for more than half of the total annual U.S. catch, surpassing all of New England.

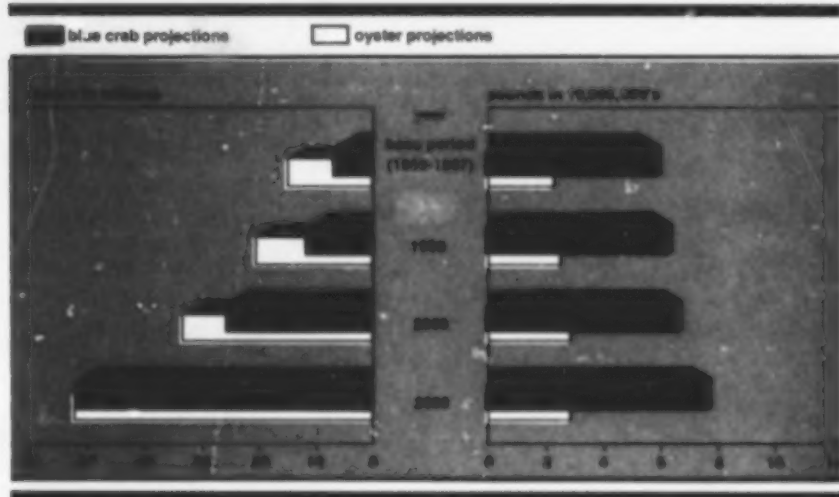
The Chesapeake is the permanent or temporary home of myriad number of animals and plants whose welfare is intimately tied to each other and to their environment. The relationship is such that adverse effects on one component of the system can affect the entire system.

The Chesapeake Bay and its surrounding wetlands are a

By State Commerce
on Chesapeake Bay 1977.
Maritime Development, Page 78

**maritime commerce
projections**





Corps of Engineers, 1979, Future Conditions Report, Volume 3, Page 134, 135

major stop along the Atlantic Flyway for migratory birds and waterfowl. They find food in its waters, agricultural lands, and beds of submerged aquatic vegetation. They also find shelter in the Bay's protected coves and extensive marshes. For some, it is only a stop before continuing their flight to wintering areas farther south, but for others it is their winter home. Most conspicuous are the more than one-half million Canadian geese and some 40,000 whistling swans, which over-winter along the Chesapeake. It is a nesting area for the endangered bald eagle and its threatened cousin, the osprey, whose largest population in the United States is found in the Bay region.

The Chesapeake's tributaries provide the necessary breeding sites for several important species of salt-water fish, such as striped bass, white perch, and shad, which must return to these areas each year to spawn. The Bay is the number one spawning area on the East Coast for the striped bass, a major commercial and sport fish. It is estimated that 90% of the stripers found from North Carolina to Maine are spawned in the Chesapeake. In the warmer months, marine species such as blue-fish, weakfish, croaker and spot enter the Bay to feed on its rich supply of baitfish and bottom-dwelling organisms.

pollution threats

Whether considered from an economic, recreational, or aesthetic point of view, the character of the Chesapeake Bay area is dominated by water quality factors. Many types of human activity have an impact on the Bay's water quality. Water pollution sources in Chesapeake Bay range from the discharge of industrial wastes, thermal discharges from power plants, municipal sewage discharges, and oil spills, to agricultural runoff (including fertilizers, herbicides and pesticides) and shoreline erosion with its attendant sedimentation.

The Chesapeake and its tributaries comprise a dynamic natural system. As such, it exhibits periodic fluctuations, whether in the types and numbers of animals and plants present at a given time, or in the chemical makeup of its waters. But as human influence on the Bay increases, the line between natural fluctuations and externally caused changes becomes obscured. It is not fully understood, for example, what has caused the osprey, sea trout, and croaker populations to increase, while duck populations have decreased; why oyster spawning has failed for the last six to eight years; and why, as indicated by the decrease of young striped bass in recent years, striped spawning has been down. In addition, there has been a dramatic decline of submerged grass beds and other aquatic vegetation necessary for the health of the entire food chain.

Up to now, the resiliency and productivity of the Bay have combined to prevent serious environmental degradation. But with the projected increases in most Bay activities, and the potential environmental impacts of these activities, the ability of the Bay to withstand future environmental damage will be severely taxed. The future of the Bay, therefore, is intimately tied to the way in which its resources will be developed and used. Because of its importance as both an ecological and economic resource, conflicts will arise between environmental and economic interests. The way in which these conflicts are resolved, the compromises that are reached, and the choices that are made will determine the future of Chesapeake Bay.

The ultimate goal of the Environmental Protection Agency's Chesapeake Bay Program is to provide solid scientific facts on which to base these choices.



EPA program

In fiscal year 1976, Congress directed the Environmental Protection Agency to conduct a five-year, \$25 million study of the environmental quality and management of Chesapeake Bay resources. Through this study — known as the Chesapeake Bay Program — the EPA was directed to coordinate research to assess the principal factors adversely impacting the Bay's water quality by coordinating pollution research to analyze, store, and distribute research data; and to determine which government agencies have resource management responsibilities and ways to optimize coordination among them.

Existing Bay research and management activities involve a broad spectrum of interests and jurisdiction: from federal, state, and local government agencies; to research institutions, commercial interests, and the public. In recognition of this diversity of concerns, EPA has designed its program to facilitate a cooperative and coordinated approach towards assuring the Bay's protection.

state participation

To assure the continuance of the cooperative effort represented by the Chesapeake Bay Program, EPA is encouraging state (Maryland, Virginia, and Pennsylvania) participation in all aspects of the Program. This enables EPA to receive assistance and support from state agencies in the areas of program planning, technical support, data compilation and processing, scientific planning, and technical program development and implementation. The lead agency in Maryland is the Water Resources Administration of the Department of Natural Resources. Its counterpart in Virginia is the Virginia State Water Control Board, and in Pennsylvania, the Department of Environmental Resources in conjunction with the Susquehanna River Basin Commission. These agencies serve as liaisons between



Chesapeake Bay Program

the Chesapeake Bay Program and other state agencies. This interactive effort is accomplished through the participation of state personnel on program policy, management, and working level committees.

public participation

To facilitate citizen input into all aspects of program management, EPA established the Public Participation Program as an integral part of its Chesapeake Bay Program. It is the main mechanism by which information flows between Bay citizens and Bay Program managers.

The Public Participation Program is managed by the Citizens Program for the Chesapeake Bay, Inc. (CPCB). This program was founded in 1971, and is an independent, non-profit, Bay-wide alliance of organizations whose purpose is to provide an avenue for the discussion of issues affecting the Chesapeake.

The main thrust of the Chesapeake Bay Program's Public Participation Program is to transmit research findings to the public so that informed choices can be made on Bay resource management issues. To assist in its public participation goals, a Citizens Steering Committee is maintained whose function is to advise EPA on the conduct of the Bay Program.

program management

In order to effectively manage the Chesapeake Bay Program, EPA established a local office in Annapolis, Maryland as an arm of its Environmental Research Laboratory in Gulf Breeze, Florida, and its Region III headquarters office in Philadelphia. This office is staffed with scientific experts and resource managers who are coordinating the EPA funded research efforts of 40 principal investigators from more than 30 institutions and organizations.

The Chesapeake Bay Program has been designed to complement current environmental studies being done by other agencies, institutions, and citizens groups. Its objectives are to describe historical trends and to help determine the current state of the Bay by evaluating ongoing research and providing new research efforts to fill in the missing pieces. The Program will also attempt to project future conditions and use this information to develop and identify control and management strategies for Bay resources and to develop implementation plans for these strategies.

In keeping with its objectives, the end products of the Chesapeake Bay Program will provide comprehensive information in the form of final reports, in five major areas: The State of the Bay; Alternative Control Methodologies; Management Methods and Applications; Feasibility of Control and Management Method Implementation; and Monitoring Strategies.

With this basic philosophy in mind, EPA established a series of policy, management and advisory committees and working groups to address problem areas. In the fall of 1977, these cooperative efforts resulted in a workshop which identified ten major problem areas to be addressed by the Program. The problem areas were then prioritized.



major problem areas

priorities

high	submerged aquatic vegetation	eutrophication	toxics accumulation in the food chain	
medium	dredging and dredged material disposal	shellfish bed closures	fisheries modification (biological resources)	hydrologic modification
low	wetlands alteration	shoreline erosion	water quality effects of boating and shipping	

current research areas

In order to maximize the use of available funds, three critical areas have received intensive, high-priority research attention:

- Submerged Aquatic Vegetation;
- Eutrophication;
- Toxic Substances.

In each of these areas, a uniform research approach is being pursued. Sources or causes of these problems are being identified and their impacts on the quality of the Bay's environment are being assessed. Models are also being developed of how pollutants interact with the Bay's ecosystem. Systems are being set up for collecting, measuring, and managing various types of environmental and other related data. Finally, control methods and alternatives for correcting the problems are being investigated.

The framework for the optimal use of research results is provided by the Environmental Quality Management Study (EQMS). For each of the three technical problem areas, this study describes the current Bay management network. That is, the roles and responsibilities of government agencies in the management of submerged aquatic vegetation, nutrients, and toxics are being delineated. Mechanisms by which control strategies may be instituted and are then described. Where these mechanisms do not currently exist, alternative methods and their costs are evaluated. This effort will incorporate the results of the research areas into an integrated management plan for improving the quality of Chesapeake Bay.

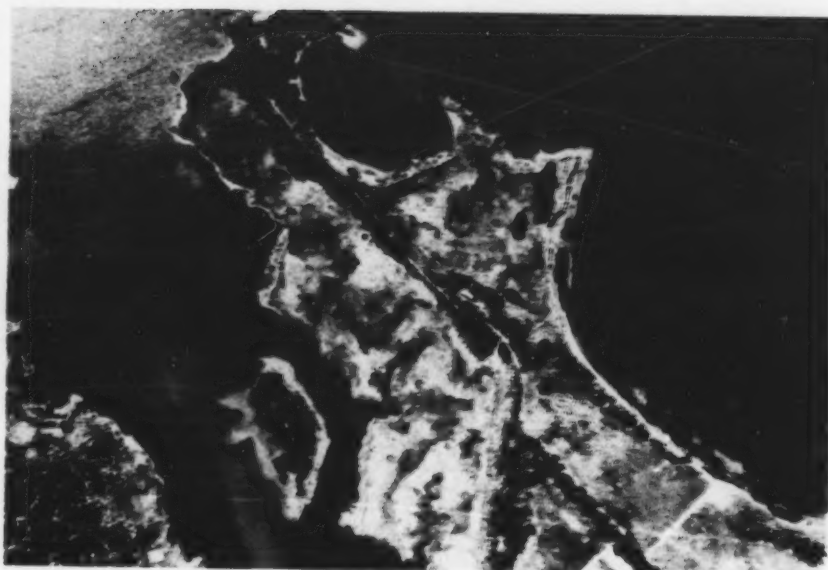
submerged aquatic vegetation

Submerged aquatic vegetation (SAV) is an integral component of the ecology of the Chesapeake Bay. Beds of submerged grasses provide food, shelter and breeding areas for waterfowl, fish, shellfish and many other organisms found in estuaries. These grasses are a significant source of food to Bay organisms providing forage for ducks, fish, shrimp, and snails, as well as, nutrients to such filter-feeding organisms as clams and oysters.

In addition to being a basic element of the estuarine food chain, the beds of submerged vegetation are also a habitat for Bay organisms. Vegetated areas provide shelter for the young of estuary-spawned fish, such as striped bass and shad, and for the economically important blue crab when it is molting. During this time, the softshell crab is especially vulnerable to predators, because of its unhardened, fleshy shell and its inability to move quickly to escape its natural enemies.

Submerged vegetation beds also play an important role in reducing both wave action and the energy of tidal and wind-driven currents in shallow areas. The vegetation slows the flow of water, allowing suspended sediments to settle out of the water column, thus reducing the turbidity, or cloudiness of the water. The reduction of wave action and currents also helps to slow erosion by dissipating much of the energy of these forces before they strike the shoreline.

In recent years there has been a sharp decline in the number and types of submerged aquatic vegetation in the Chesapeake Bay system. This has caused alarm because it seems to correlate with the overall ecological health of the Bay and may be an indicator of significant environmental damage. For this reason, understanding how and why these valuable vegetation beds are disappearing is a major part of the Chesapeake Bay Program. To find the answers, a comprehensive research



effort has been instituted to determine the current distribution and abundance of these plants in the Bay, their physiological and ecological requirements for growth, reproduction and survival, and their functional role in the Bay ecosystem. The effects of human activities on submerged aquatic vegetation and its usefulness as indicators of Bay environmental quality are also being examined. Research accomplished under these tasks will provide the information needed to determine the environmental conditions necessary for the improved growth and enhancement of submerged aquatic vegetation.

baseline studies

As a first step, scientists are establishing "baseline data" by determining the current status of these plants in the Bay, and where possible, identifying growth trends over time.

The Virginia Institute of Marine Science and the American University are conducting EPA-sponsored studies leading to an inventory of submerged aquatic vegetation throughout the Bay. Aerial reconnaissance is being used extensively, and photo interpretation is being compared and verified by on-site field research. Part of this effort has been to establish trends in selected areas where historical data, particularly aerial photos, are available.

In an associated project, the Johns Hopkins University

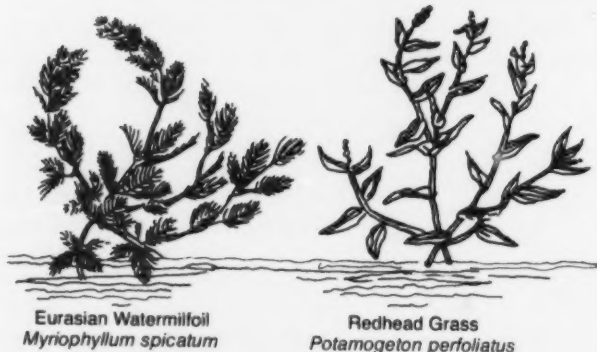


Eric Poggenpohl

is charting the natural life cycles of submerged aquatic vegetation over the past few hundred years. Researchers are correlating deviations from these cycles due to human activities or natural events. This is done by analyzing seeds and pollen of submerged vegetation through core samples from the Bay bottom. Data from this analysis is then related to historical records of natural and human-related events.

ecological role

In addition to establishing "baseline" or inventory data, a substantial portion of the SAV program is



dedicated to learning more about the ecological role of submerged aquatic vegetation in Chesapeake Bay.

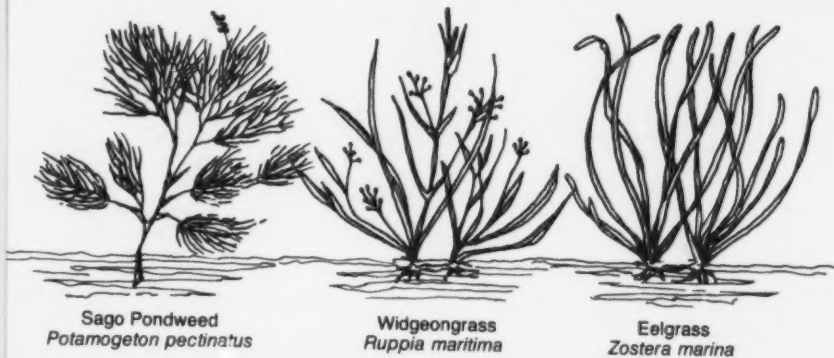
EPA is funding research by the Virginia Institute of Marine Science on the ecology of submerged aquatic vegetation in the Virginia portion of the Bay. Research efforts are concentrating on eelgrass, the predominant submerged plant in the lower Bay. This study addresses the productivity, cycling of nutrients and associated microbial life; the interaction of organisms which either ingest eelgrass directly or reside in the eelgrass bed; and higher level interactions between bluefish, sea trout, and weakfish and their prey species.

These studies will be helpful in evaluating the value of eelgrass communities, in understanding the role of eelgrass in the Bay ecosystem — especially with respect to animal life important to man. The studies will result in computer model simulating the ecological role of eelgrass in the Bay.

effects of herbicides

Although agricultural herbicides are suspected of being one of the causes for the decline of submerged aquatic vegetation in the Bay, there is no reliable evidence of their impact. Herbicides enter the Bay by way of runoff from adjacent farmlands. To obtain better data on the effects of herbicides on eelgrass, researchers at the Virginia Institute of Marine Science are identifying seasonal and monthly levels of herbicides in the Bay and studying their relative impacts under controlled laboratory conditions.

Suspended sediments are also suspected of playing a role in the decline of submerged aquatic vegetation by



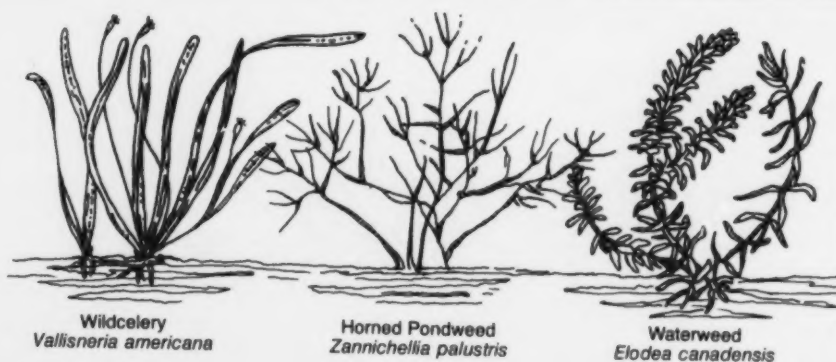
blocking much of the light needed for photosynthesis. The light reduction may be due to either excessively murky waters resulting from high concentrations of suspended sediment and dissolved organic material or to the coating of leaves and stems by sediment trapped by the plants.

Finally, Institute scientists are developing technology for propagating and establishing eelgrass beds to create additional habitats. Techniques are being developed to collect, store, and germinate seeds, and to culture seedlings in the laboratory for planting in the wild. Techniques to transplant the wild plants are also being investigated.

In an EPA funded companion study, scientists at the Center for Environmental and Estuarine Studies of the University of Maryland are investigating the role of submerged aquatic vegetation in the Bay ecosystem and the factors leading to its decline. An objective of this effort is to assess the stress put on submerged aquatic vegetation by herbicides and to determine if these effects are increased by excess turbidity due to suspended sediments. In addition, the pathways and mechanisms by which herbicides and sediments are carried through the Bay are being examined.

management options

The culmination of this effort will be an evaluation of management options for controlling factors contributing to the decline of submerged vegetation. In order to perform this evaluation, herbicide, sediment, and nutrient levels for selected Bay tributaries such as the Patuxent and Choptank rivers, will be determined by using the data gathered from all phases of this project.



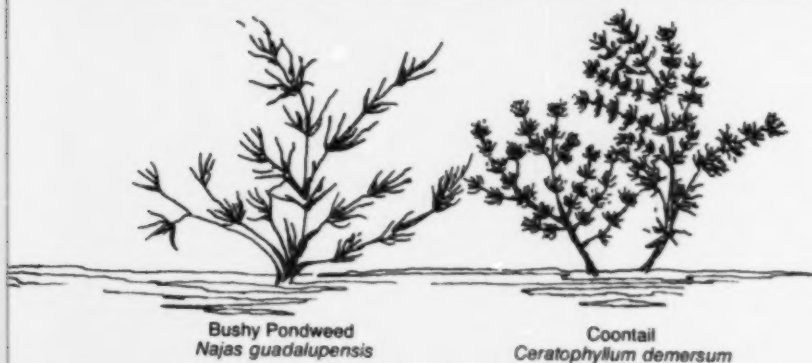


Peter Mavraganis

Heavy small boat traffic on the Bay and its tributaries leads to turbulence which may cause the resuspension of bottom sediments. A cooperative project between the U.S. Naval Academy and Anne Arundel Community College is being conducted to evaluate the effects of recreational boating on turbidity and sedimentation in relation to submerged aquatic vegetation.

synthesis

The task of synthesizing the data obtained by researchers in the submerged aquatic vegetation program area has been undertaken by scientists at the Migration, Bird and Habitat Research Laboratory (MBHRL) of the U.S. Fish and Wildlife Service. The lab is evaluating the factors affecting and the importance of submerged aquatic vegetation in Chesapeake Bay. This project has two major objectives.



The first is to determine the importance of submerged aquatic vegetation as a food source for migratory waterfowl in the Bay. Historical data (1889 to the present) on waterfowl feeding patterns and habitat preferences are being compiled and analyzed. The resulting information will then be related to data on current waterfowl distribution and feeding patterns. The result will be an analysis of the past and present relationships between waterfowl and submerged aquatic vegetation.

The second objective of the MBHRL study is the development of a SAV monitoring strategy and the synthesis of all research data. Correlating research results with information related to the effects of human activities on submerged aquatic vegetation will enable scientists to determine the likely causes of declines of these valuable plants. This will lead to the delineation of environmental conditions necessary for improved growth of submerged aquatic vegetation which will provide Bay resource managers with the information they need to evaluate management options.



eutrophication

Eutrophication refers to the natural or artificial addition of nutrients to bodies of water. These nutrients are essential to the normal life processes of estuarine plants and animals. In the natural state, nutrients provided by decaying organic material result in a well nourished, highly productive, eutrophic condition. Water quality problems arise, however, when there are too many nutrients due to either natural events or, more often, to human activities.

Major sources of man-made nutrients include fertilizer run-off from agricultural lands and sewage discharges from treatment plants and septic tank leakage. The discharge water from most sewage treatment plants is rich in nutrients because the treatment mainly eliminates bacteria — not the chemicals that comprise nutrients. Those chemicals are primarily nitrogen and phosphorus compounds.

Increased shoreline development can also result in large infusions of nutrients. This occurs when land is stripped of vegetation and large amounts of decaying organic matter are exposed to erosion and are washed into the water along with sediments.

Excessive nutrient enrichment causes accelerated growth of plant species, particularly phytoplankton (free floating microscopic plants) and algae. The resulting plankton algal "blooms" produce numerous water quality problems including noxious odors and toxic metabolic products which can cause fish kills. Sometimes this overgrowth clogs the water, blocking light that is needed by desirable submerged plants. Less dramatic, but equally important, are the dissolved oxygen supply problems created by these blooms. Although these are oxygen-producing plants, they consume much more oxygen than they produce during this accelerated growth state, drastically lowering the dissolved oxygen in the water that is necessary for sustaining fish and



Eric Poggenpohl

other aquatic life. The extremely short life span of these plankton creates an additional dissolved oxygen demand since large amounts of oxygen are used during decomposition of dead plants. Again, this can result in depletion of fish, shellfish, and vegetation.

Various parts of the Chesapeake have experienced problems from excessive nutrient enrichment. This is particularly evident in many of the tributaries and in the upper Bay.

Although eutrophication is a natural process, its acceleration can turn ponds and lakes into swamps and bogs and can hasten the complete stagnation of some bodies of water. Although this process is better understood in lakes, much needs to be learned about how eutrophication affects estuarine systems. For this reason, the Chesapeake Bay Program has instituted a carefully designed eutrophication research program which will determine the state-of-the-Bay with regard to nutrient enrichment. It will quantify the nutrient loadings into the Chesapeake Bay, define acceptable ranges of nutrient levels in the Bay for the years 1990 and 2000, and evaluate control alternatives for present and future conditions.

In order to implement eutrophication control measures in a manner beneficial to Bay resources, the relationship of nutrients to water quality must first be thoroughly understood, particularly for an estuarine environment. The Chesapeake Research Consortium, under EPA's sponsorship, is conducting a study addressing this

subject with specific attention to defining excessive nutrient enrichment problems. Researchers are identifying the fundamental processes involved in the entire Bay system and historic trends in nutrient enrichment as compared to current levels. This effort will culminate in a final report, delineating eutrophication trends and providing a better understanding of the eutrophication process in the Bay and in estuaries in general.

Nonpoint sources of nutrients into the Chesapeake originate on land bordering tributaries and the Bay shores. Because it is difficult to pinpoint these nutrient sources, one of the best ways to determine nutrient loadings is to study the flows of the watersheds feeding into the Bay. Part of EPA's eutrophication research program involves the evaluation of five watersheds of the Chesapeake Bay system. The selected watersheds include a three-state area: Pennsylvania, Maryland, and Virginia.

watershed studies

Five projects have been initiated to assess the relative magnitude of nonpoint sources of nutrients from various land-use categories: in Virginia (the Occoquan and Ware River basins), performed by the Virginia State Water Control Board; in Maryland (the Patuxent and Chester River basins), performed by the Maryland Water Resources Administration, and the Pequea Creek basin, Lancaster County, Pennsylvania, performed by the Susquehanna River Basin Commission.



In addition to the field verification of nonpoint source runoff, these complimentary studies are providing data necessary to evaluate tools for predicting the water quality impacts of eutrophication, and the cost-effectiveness and accuracy of those tools. Data from the watershed studies are being used by EPA's Environmental Research Laboratory in Athens, Georgia, to evaluate computer models designed to identify the factors affecting eutrophication in the Bay.

Through an interagency agreement with EPA, the U.S. Geological Survey is conducting fall-line monitoring of the Potomac, Susquehanna, and James Rivers. The fall-line is the point of freshwater discharge to tidal rivers. This two year intensive study will characterize the chemical, physical, and organic inputs from major Bay freshwater sources on a seasonal basis. It will assist in evaluating impacts due to land and water use, and economic developments in the non-tidal portions of these rivers. Information gathered during this effort will also be used in the validation of Bay water quality models.

Land use practices can significantly affect the nutrient levels of receiving waters. For example, increased municipal and industrial developments in watersheds can create a corresponding increase in nutrient discharges, particularly nitrogen and phosphorus. As part of the eutrophication program area, analyses are being performed on long range land use and point source nutrient loading for the Chesapeake Bay region. This information will be used to develop projections to the year 2000 of land use patterns and nitrogen and phosphorus loadings from municipal and industrial sources.





Chesapeake Bay

A knowledge of water circulation in the Chesapeake is important to support resource management and regulatory activities. This knowledge permits reasonable predictions of pollutant and sediment flow. Under an EPA research contract, a computerized model of Chesapeake Bay water circulation is being developed which will stimulate circulation patterns and assist in understanding pollutant pathways. This model will also serve as the basic building block for more specific models relating to aspects of Chesapeake Bay water quality.

future efforts

Newly funded EPA research will assist in further defining the nutrient composition of the entire Bay. This will be accomplished by expanding the nutrient data collection efforts to include comprehensive data from the Bay proper augmented by nutrient data from the mouth of the Bay and from other critical boundary areas. Nutrient contributions from the atmosphere will also be evaluated in order to account for other possible sources. By mid-1981, water quality models of the main Bay and tributaries will be developed. The nutrient data will be used in the calibration and verification of these models. Once this is accomplished, the models will be used to determine likely trouble spots and to project future water quality conditions under various management situations.

toxic substances

Toxic substances are chemicals or chemical compounds that can be hazardous or poisonous to plants and animals, including humans. There are a large number of potentially toxic substances having varying degrees of toxicity. Some substances such as trace metals occur naturally and can become environmental hazards when their concentrations are increased most often as a result of human activities. The vast majority of toxic substances, however, are by-products of our industrialized society. Pesticides, herbicides, constituents of industrial waste streams, various organic chemicals, and petroleum-based products are all potentially toxic.

Toxic substances enter the Bay just as do nutrients, from either point or non-point sources. Toxic point sources may be industrial plant discharges, or accidental spills from vessels, or shoreline storage facilities. Nonpoint sources can be as diverse as runoff from agricultural lands and paved urban areas, to rainfall or atmospheric fallout.



Since most of these substances are persistent in the environment, the accumulation of toxics in the food chain and the potential adverse ecological and human health impacts are a primary concern of the Chesapeake Bay Program. In order to establish the role of toxics in the Bay ecosystem, a thorough understanding of the Bay's chemical, physical, and biological dynamics is necessary. It is particularly important to develop reliable information on the current levels of toxics in the Bay, as well as information on the sources, pathways and fate of these substances in the estuarine environment.

Research efforts in the toxics program area center on obtaining this information by studying the behavior of toxic materials from industrial, agricultural, and atmospheric sources. From such studies, resource management and regulatory strategies can be designed to reduce or eliminate environmental hazards and protect and improve the quality of the Bay.

baseline studies

The Virginia Institute of Marine Science is conducting an investigation of organic pollutants in the Chesapeake Bay. Baseline data on the abundance and distribution of toxic organic compounds in the water, sediments and shellfish are being developed along with a system for monitoring organic pollutants. Water and sediment samples are being collected from various sites. Shellfish tissue samples are being obtained from the American oyster (*Crassostrea virginica*) because it is located throughout most of the Bay and has an affinity for concentrating pollutants in its tissues. In areas where oysters may not be found, tissues of the brackish water clam (*Rangia cuneata*) will be substituted.



transport and fate

Through an interagency agreement with EPA, the National Bureau of Standards (NBS) is conducting a baseline analysis of toxic trace elements for the Chesapeake Bay Program. Water samples from the top and bottom of the water column, collected at fixed locations throughout the Bay, are being analyzed for concentrations of twelve key trace elements: copper, lead, zinc, cadmium, manganese, molybdenum, nickel, chromium, tin, mercury, arsenic, and selenium. This baseline data, when complete, will serve as a benchmark for future testing of toxic trace element concentrations.

In order to efficiently assess the effects of pollutants and, on occasion, to find pollutant sources, it is necessary to understand the mechanisms and pathways by which they travel through the environment. The prevention of environmental degradation due to estuarine shoreline development depends on a knowledge of the transport mechanisms which disperse discharged wastewater and its potentially damaging constituents. Recognizing the importance of this aspect of toxic substances research, several projects in this program area address the transport and fate of toxics in the Bay.

The Chesapeake Bay Institute of the Johns Hopkins University is conducting a study monitoring toxic substances associated with sediment particles and suspended sediment in the Bay. Rates and patterns of movement of toxics associated with suspended particles are being established. An analysis of the seasonal fluctuation of physical and chemical characteristics of suspended sediment is also being undertaken both in the main Bay and in selected major tributaries.

In a companion study performed by the Virginia Institute of Marine Sciences, researchers are determining the role of suspended sediment and fluid mud in the fate, transport, and transformation of toxics. The types and concentrations of toxic metals are being examined by season and by location to determine patterns of occurrence. Along with this, investigations are in progress to determine the affinity of toxic metals to certain types of suspended sediments, and the rates and pathways of pollutant transport from the source to the deposition area.

As an adjunct to the above studies, the University of Maryland is performing a geochemical survey of Chesapeake Bay bottom sediments in an effort to determine the types and amounts of trace metals



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bottom sediment

present. Data generated from this study will allow estimates to be made of the rates at which individual trace metals enter bottom sediments. This project will yield maps showing the current chemical quality of Bay sediments in relation to trace metals, and will result in data on the areas of deposition of trace metals in the

The mechanisms by which toxics move from the water column into bottom sediments and vice versa, are a very important aspect of pollutant transport. One such mechanism involves interstitial water, which is the water occurring from the estuary bottom to about one meter below the sediment surface. The water is trapped by the sediment and provides a medium by which pollutant exchange between sediment and the water column can occur. A study by the Maryland Geological Survey is being conducted to elucidate the chemistry of interstitial water. Researchers are working to understand the chemical reactions that govern the concentrations of trace metals and chemical compounds that are active in this zone, and are identifying the transport mechanisms present in interstitial water. Chemical analyses of water samples are also being performed by chemists at the College of William and Mary. This study will result in a better understanding of interstitial waters as a source of trace metals and will generate the data necessary to develop a computer model of the behavior of trace metals in the Chesapeake Bay.

**point source
assessment**

Another mechanism by which pollutants can be transferred between bottom sediments and the water column is through the activities of benthic or bottom-dwelling organisms. Most of these organisms are concentrated in the top few centimeters of sediment. Their activities, such as feeding and burrowing, can keep sediment particles in a state of flux enhancing the exchange of dissolved particles between sediment and water. Companion studies by the Virginia Institute of Marine Science and by the Maryland Geological Survey are being conducted to investigate this animal-sediment relationship to obtain a better understanding of the role of benthic organisms in the pollutant transport process.

Complimentary projects are being performed by the Virginia Institute of Marine Science and the Maryland Geological Survey to investigate Bay sedimentology. Shoreline erosion and runoff from sparsely vegetated and unvegetated land are major sources of suspended sediments. These sediments enter the Bay through tributaries and from the Bay shoreline. In addition to identifying the distribution and physical properties of sediments, these studies are being conducted to locate areas of erosion and, most importantly, the areas in the Bay where these sediments are deposited.

EPA's Industrial Environmental Research Laboratory (IERL) in Research Triangle Park, North Carolina, is coordinating contractor research in toxic point source assessment. This involves characterizing, inventorying, and prioritizing the potential toxicity of industrial effluents discharged into the waters of the Chesapeake Bay basin.

The initial phase of the assessment involves developing an inventory of industrial sources discharging potentially toxic substances, determining the chemical composition and quantities of these discharges, and prioritizing the industrial facilities according to potential toxicity of their effluents. As a result of this, the Chesapeake Bay Program Toxics Work Group (consisting of representatives from Maryland, Virginia, EPA Region III headquarters in Philadelphia, and Chesapeake Bay Program Staff) has selected the effluents of 80 industrial discharge points for more comprehensive study and testing.

The final phase of the toxic point source assessment will describe the 80 selected effluents, by identifying individual organic compounds within each effluent stream and testing their potential for being absorbed by estuarine organisms.

individual research projects

submerged aquatic vegetation

- Distribution of Submerged Aquatic Vegetation in Chesapeake Bay, Maryland. (The Chesapeake Bay Foundation, and the American University)
- Distribution and Abundance of Submerged Aquatic Vegetation in the Lower Chesapeake Bay. (Virginia Institute of Marine Science)
- Biostratigraphy of the Chesapeake Bay. (Johns Hopkins University)
- The Functional Ecology of Submerged Aquatic Vegetation in the Lower Chesapeake Bay. (Virginia Institute of Marine Science)
- *Zostera Marina*: Biology, Propagation and Impact of Herbicides. (Virginia Institute of Marine Science)
- Submerged Aquatic Vegetation in the Chesapeake Bay: Its Role in the Bay ecosystem and Factors Leading to its Decline. (Center for Environmental and Estuarine Studies, Horn Point Environmental Laboratories, University of Maryland)
- Effects of Recreational Boating on Turbidity and Sedimentation Rates in Relation to Submerged Aquatic Vegetation. (U.S. Naval Academy and Anne Arundel Community College)
- Factors Affecting, and Importance of Submerged Aquatic Vegetation in Chesapeake Bay. (Migration, Bird and Habitat Research Laboratory, Patuxent Wildlife Research Center, U.S. Fish and Wildlife Service)

eutrophication

- Definition of Chesapeake Bay Problems of Excessive Enrichment or Eutrophication.
(Chesapeake Research Consortium, Annapolis, Maryland)
- Evaluation of Management Tools in Two Chesapeake Bay Watersheds in Virginia.
(Virginia State Water Control Board)
- Evaluation of Water Quality Management Tools in the Chester River Basin.
(Maryland Water Resources Administration)
- Intensive Watershed Study (Patuxent River Basin)
(Water Resources Administration, Maryland Department of Natural Resources)
- An Assessment of Nonpoint Source Discharge, Pequea Creek Basin, Lancaster County, Pennsylvania.
(Susquehanna River Basin Commission)
- Modeling Philosophy and Approach for Chesapeake Bay Program Watershed Studies.
(U.S. EPA Environmental Research Laboratory, Athens, Georgia)
- Fall Line Monitoring of the Potomac, Susquehanna, and James Rivers.
(Water Resources Division, U.S. Geological Survey)
- Land Use and Point Source Nutrient Loading in the Chesapeake Bay Region.
(GEOMET, Incorporated)
- Chesapeake Bay Circulation Model.
(Water Resources Engineers, Inc.)

toxic substances

- Investigation of Organic Pollutants in the Chesapeake Bay.
(Virginia Institute of Marine Science)
- The Characterization of the Chesapeake Bay: A Systematic Analysis of Toxic Trace Elements.
(Office of Environmental Measurements, National Bureau of Standards)
- Monitoring Particle-Associated Toxic Substances and Suspended Sediment in the Chesapeake Bay.
(Chesapeake Bay Institute, The Johns Hopkins University)
- Fate, Transport and Transformation of Toxics: Significance of Suspended Sediment and Fluid Mud.
(Virginia Institute of Marine Science)

- Chesapeake Bay Sediment Trace Metals.
(University of Maryland)
- Interstitial Water Chemistry — *Chesapeake Bay Earth Science Study*.
(Maryland Geological Survey, The Johns Hopkins University)
- Sediment and Pore Water Chemistry
(College of William and Mary)
- The Biogenic Structure of Chesapeake Bay Sediments.
Division of Biological
(Virginia Institute of Marine Science)
- Animal-Sediment Relationship.
(Maryland Geological Survey, The Johns Hopkins University)
- Baseline Sediment Studies to Determine Distribution, Physical Properties, Sediment Budgets and Rates.
(Virginia Institute of Marine Science)
- Sedimentology of the Chesapeake Bay — *Chesapeake Bay Earth Science Study*.
(Maryland Geological Survey, The Johns Hopkins University)
- Inventory and Toxicity Prioritization of Industrial Facilities Discharging into the Chesapeake Bay Basin.
(OCA Corporation)
- Toxic Point Source Assessment of Industrial Discharges to the Chesapeake Bay Basin.
(Monsanto Research Corporation)

Peter Mavraganis



**for further
information**

publications

- EPA Research Highlights 1979. January 1980. EPA-600/9-80-005. 100 Pages.

Highlights of the EPA research program accomplishments of 1979.

- EPA Research Outlook. February 1980. EPA 600/9-80-006. 224 Pages.

A concise description of the EPA's plans for future environmental research.

- EPA/ORD Program Guide. October 1979. EPA 600/9-79-038. 85 Pages.

A guide to the Office of Research and Development—its organizational structure, program managers, and funds available for contracts, grants, and cooperative agreements.

**other research
summaries**

- EPA Research Summary: Controlling Nitrogen Oxides. February 1980. EPA-600/8-80-004. 24 Pages.

- EPA Research Summary: Acid Rain. October 1979. EPA-600/8-79-028. 24 Pages.

- EPA Research Summary: Oil Spills. February 1979. EPA-600/8-79-007. 16 Pages.

- EPA Research Summary: Controlling Hazardous Wastes. May 1980. EPA-600/8-80-017. 24 Pages.

Information on the availability of these publications may be obtained by writing to:

Publications
Center for Environmental Research Information
U.S. EPA, Cincinnati, OH 45268

or by calling (513) 684-7562

technical reports

- Chesapeake Bay Program: Summary of Projects. October 1979. EPA-600/8-79-030/Program Report 1. 72 Pages.
- Chesapeake Bay Program: Distribution and Abundance of Submerged Aquatic Vegetation in the Lower Chesapeake Bay, Virginia. October 1979. EPA 600/8-79-029/SAV 1. 219 Pages. (PB-80-140-726, \$13.00)
- Summary of Available Information on Chesapeake Bay Submerged Vegetation. August 1978. FWS/OBS-78/66. 335 Pages. (PB-285-795, \$19.00)
- Decline of Submerged Aquatic Plants in Chesapeake Bay. July 1979. FWS/OBS-79/24. 12 Pages. (PB-80-114-747, \$5.00)

Technical Reports may be obtained by writing to:

National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161
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questions or comments

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Chesapeake Bay

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